

Synopsis V1.0
Proton Testing of the Zarlink Semiconductor
GP2021 GPS 12-Channel Correlator

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Test Date: June 6, 2002

Report Date: April 11, 2003.

I. Introduction

This study was undertaken to determine the proton Single Event Effects (SEE) and total dose susceptibility of the Zarlink Semiconductor GP2021 GPS 12-Channel Correlator. The device was biased and operating when exposed to a proton beam at the Indiana University Cyclotron Facility (IU).

II. Devices Tested

Four parts were exposed for this testing. The devices were manufactured by Zarlink Semiconductor and were characterized prior to exposure. The devices were all from lot date code 9617A.

III. Test Facility

Facility: Indiana University Cyclotron Facility

Proton Energy: 189.9 MeV incident on DUT structure

Flux: 2.3×10^8 to 5.6×10^8 protons/cm²/s.

IV. Test Methods

Figure 1 shows the block diagram for the test hardware setup used for this testing. Basically, the hardware starting on the left with the Welnavigate box, is used to simulate the signals that the GPS satellite would transmit. This is input into the correlator, locking the system onto that signal. The remainder of the hardware is to monitor the status of that lock.

Two correlator devices are then placed in the proton beam, simultaneously, and the lock status is monitored as the device is continually exposed. An upset condition is the loss of lock on any one or more channels that self clears after a short interval. A function interrupt (SEFI) event is one where there is a loss of lock on one or more channels and a power cycle is required to recover lock. A functional failure is a condition when the

cycling of power does not recover lock. As the hardware system did not allow for the direct measurement of the device current, accurate determination if the failure was due to total dose or latchup could not be determined.

V. Results

For the four devices that were tested (two at a time), there were 30 upset events seen over the course of approximately 1.2×10^{12} protons/cm² fluence. This gives a per-device upset cross section of approximately 1.3×10^{-11} cm². In addition to the upset events, four SEFI events were observed, leading to a SEFI cross section of approximately 1.7×10^{-12} cm². Two failure events were also observed (power cycle did not recover). The first occurrence, for the first pair of correlators, was after approximately 8.3×10^{11} protons/cm² fluence (about 49 krads(Si)). The second occurrence, for the second pair of correlators, was after approximately 3.5×10^{11} protons/cm² fluence (about 20 krads(Si)). The first of these failure events is most likely attributed to total dose failure based on prior Total Ionizing Dose (TID) test results. The second event is not as clear. Either there is significant part-to-part variation in the dose failure point or a latchup (or other destructive event) occurred on one of the second pair of devices. Assuming that the second event was indeed a latchup and the first failure event was not, then the approximate latchup cross section is 4.3×10^{-13} cm².

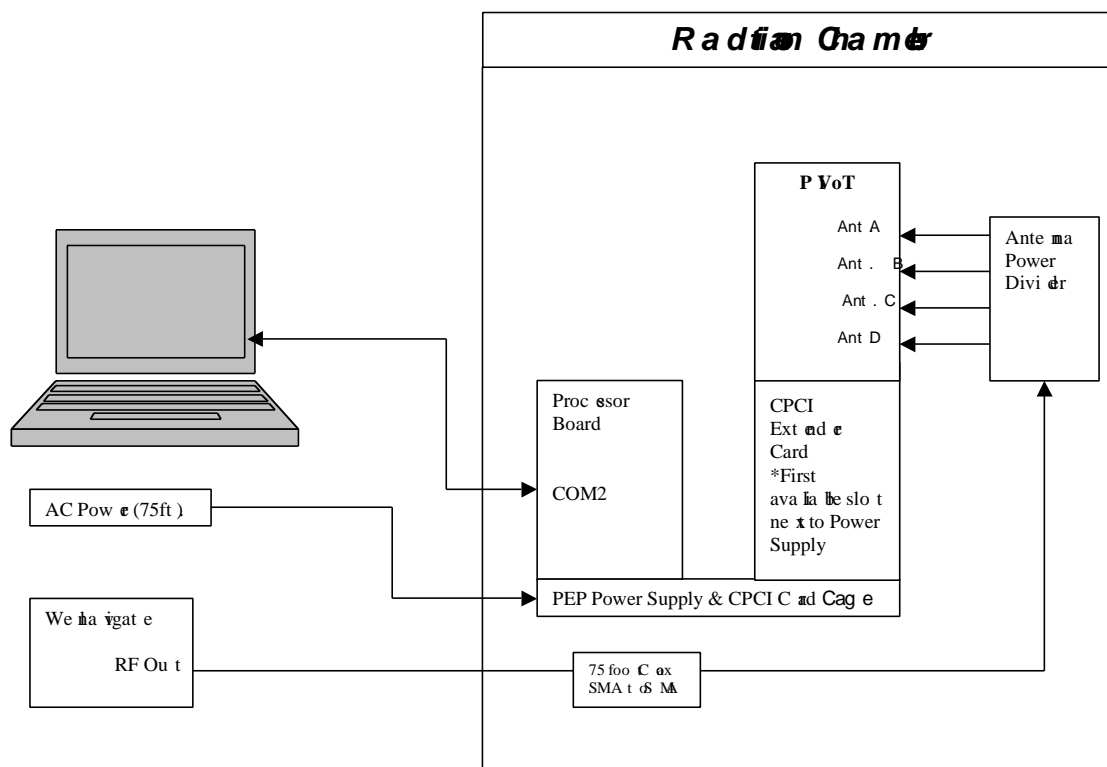


Figure 1. Block Diagram of Test System for the Zarlink GP2021 GPS 12-Channel Correlator.

VI. Recommendations

In general, devices are categorized based on test data into one of the four following categories:

Category 1 – Recommended for usage in all NASA/GSFC spaceflight applications.

Category 2 – Recommended for usage in NASA/GSFC spaceflight applications, but may require mitigation techniques.

Category 3 – Recommended for usage in some NASA/GSFC spaceflight applications, but requires extensive mitigation techniques or hard failure recovery mode.

Category 4 – Not recommended for usage in any NASA/GSFC spaceflight applications.

The Zarlink Semiconductor GP2021 GPS 12-Channel Correlators are Category 3 devices.